U.S. Department of Energy

Tomorrow's Energy Today

for Cities and Counties

Public Utilities Supply Solar Energy to Eager Customers

Photovoltaic power—it's an alternative source of energy that can help utilities earn goodwill from their customers for being innovative, saving money, and reducing harmful emissions.

Customers of local, publicly owned electric utilities are more sophisticated today than ever before. They demand the best—power that's clean, economical, and reliable. You can satisfy your customers, achieve portfolio diversity, and get help with demand-side management. How? With photovoltaic power—the direct conversion of sunlight to electricity (see p. 5).

Planners at municipal utilities are discovering the advantages that photovoltaic (PV) power offers. In addition to the thousands of private, federal, state, and commercial PV systems installed during the last 20 years, more than 65 cities in 24 states also have installed such systems.

PV power is cost effective in selected utility applications today, and those applications are expanding every year. PV can be useful in applications ranging from low-power uses to decentralized applications to large, central stations. Public utilities in Austin and Sacramento are among those successfully using PV power for all three types of applications. Their stories follow.

Photovoltaics (PV) works for all of us. These senior residents of Austin's ECHO Village benefit from reduced utility bills because of a rooftop PV system installed on their homes.

Kevin Virobik-Adams, Progressive Photo / VL731

Austin Electric's PV Applications

City of Austin Electric Utility, owned by the City of Austin, Texas, serves a metro area of about 421 square miles (1090 square kilometers). The utility uses PV power for numerous applications, including

PV300—This 300-kW, grid-connected, flat-plate tracking system was installed in 1986 as a demonstration of bulk power production from a PV power plant in a centralized location.

Youth Hostel—This 2.3-kW, grid-connected, flat-plate system was installed in 1990 on the roof of a

"PV helps you form a good partnership with your customers."

—John Hoffner
Program Manager of Alternative Energy
City of Austin Electric Utility

Kevin Virobik-Adams, Progressive Photo/VL730

Many visitors see firsthand Austin's efforts at sustainability when they lodge at the city's youth hostel. The hostel uses a 2.3-kW photovoltaic system.

youth hostel owned by the city. According to John Hoffner, the utility's Program Manager of Alternative Energy, "The hostel is a great visual demonstration of PV, with so many visitors going in and out. The concept of this hostel is to be sustainable—it has recycling, efficient lighting, low-water landscaping, and PV." This project was cofunded by the city utility and the State of Texas.

ECHO Village—This 3.2-kW flat-plate system was completed in 1991 for ECHO Village, a group of six homes for elderly residents on fixed incomes. The city utility worked with an architect to design the homes. The PV modules are located on the rooftops. The city operates and maintains the PV systems, and village residents benefit from reduced utility bills.

PVUSA Host—This 20-kW, grid-connected, flat-plate system was installed in 1992 as a host site for the PV for Utility-Scale Applications (PVUSA) project. It was installed in conjunction with the opening of Austin's new convention center. "We're looking at this system as a possible commercial DSM [demand-side management] application," Hoffner says. "The City Council wanted the convention center to be a model of energy efficiency. It has everything from efficient lighting systems to low-flush toilets to PV."

Water flowmeters—The utility also uses off-grid PV systems to power 15 water flowmeters used by Austin Water, the city's water and wastewater department. The initial capital-cost savings for the PV installations were substantial. The estimated line extension cost for all 15 sites was about $100,000, compared to $24,000 for the same 15 sites when powered by PV. That's an initial savings of $76,000. "We charge the Water Department a fixed monthly fee of $12 for each PV system," Hoffner adds. "It has been very cost effective."

Success Leads to More Installations in Austin

Austin Electric's experience with its PV systems has been positive. "Availability to run has been greater than 90% during sunlight hours," Hoffner says. "We've had a few start-up problems, but we'd expect that with any new system. After start-up, the systems have run smoothly.

"Our utility studied all the alternative technologies—Austin has always been interested in sustainable-energy technologies. And the customers want solar to work. The majority of our customers think it's an effective way to make electricity."

Hoffner recommends using a screening mechanism that kicks in right when a request for power comes in. "The screening mechanism could determine factors such as how much power is being requested and how far from the utility the load will be."

Sacramento Municipal Utility District's Experience with PV

Another utility that has had success with many types of PV applications is the Sacramento Municipal Utility District (SMUD). Located in Sacramento County, California, SMUD is the fifth-largest public utility in the country, serving an area of 900 square miles (2331 square kilometers).

Among the PV systems SMUD operates are

- The world's longest operating, large PV plant, a 2-MW flat-plate system at the site of the now closed Rancho Seco nuclear generating station

What Can Photovoltaics (PV) Do for Your Public Utility?

Some of the reasons cited by city and county personnel for installing PV-powered systems are that they

- Increase siting flexibility for regulated installations, such as school zone flashers
- Reduce required installation lead time by eliminating the need to request utility service hookups
- Create a more aesthetic installation by eliminating overhead electrical lines
- Increase system reliability by using a power supply that can survive power outages in emergency situations
- Save money.

- A 200-kW flat-plate system, sited at Hedge Substation
- A 12-kW flat-plate, electric vehicle recharging station for SMUD fleet
- A 40-kW concentrating system mounted on a warehouse roof
- 108 flat-plate, grid-connected systems that total 400 kW. These are located on the rooftops of residences. They feed into the grid, and customers pay a fee of $6 per month. Customer response has been so positive that SMUD plans to install another 135 of these systems in 1994.

"We've had extremely good experience with PV, especially in bringing plants on-line," says Donald Osborn, SMUD's Solar Program Manager. "We've had far fewer start-up problems with PV projects than with conventional plants."

One reason is that PV systems are fast to install. From start to finish, SMUD's 200-kW substation took less than 6 months to complete; the 12-kW recharge station took only 1 month. And a 4-kW residential rooftop system now takes only 3 hours to install.

Osborn says that once they are operating, the systems are extremely reliable. "The 2-MW plant is essentially unattended. Very little maintenance is required."

Initial cost savings is another big bonus. "For example, we were installing street lights in downtown alleys to increase safety and reduce crime," Osborn says. "It costs $5,000 to $6,000 to put in conventional lights, once you consider trenching, conduit, and other factors such as overhead. But the PV lights cost only $3,000 installed. That's an immediate savings of at least $2,000." Osborn concludes, "If you're not using PV for remote and selected distributed-power applications now, you're throwing money away."

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Solar Program Manager
Sacramento Municipal Utility District

What Applications Are Cost Effective Today?

Hoffner agrees. "Small PV systems are much cheaper than running a new power line, replacing and disposing of primary batteries, or using an engine generator. We were really surprised to compare the cost of using PV power with that of the labor, transformers, trenching, and other factors making up the infrastructure costs that support so many small projects."

In fact, the Electric Power Research Institute (EPRI) has identified more than 60 different cost-effective applications (see *For More Information*). EPRI's studies uncovered applications in every major area of electric utility operations—transmission and distribution, environmental monitoring, communications, sensors, warning sirens, and bus shelters.

Demand-Side Management

Another potential use for PV systems is for demand-side management (DSM), or more specifically, demand-side supply. Some utilities use DSM to reduce their peak demand, which, for summer-peaking utilities, occurs on hot, sunny afternoons when many customers are running air conditioners. Meeting this peak demand is costly because the utility must fire up peaking power plants, the most expensive to operate. Usually, the utility must supply the peak demand for just a few hours a day, for only a few days a year. The utility's electric generation and distribution systems have to be sized to handle these peak loads.

Installing grid-connected PV arrays on rooftops may become a good demand-side supply tool for summer-peaking utilities. The PV-generated electricity is used directly to help supply a building's peak demand, which often coincides with times when the sun is shining the brightest and PV output is high. For large buildings, such as office buildings, PV-demand-side supply generally will contribute all year long, although its most valuable contribution is in the summer.

"Although it's too early yet to rely on only PV for DSM, we're finding that tying multiple DSM strategies together is a strong approach," says Hoffner. "For example, say you have 4000 customers who have a load-control switch on their air conditioners. The utility can use this switch to turn off air conditioners at peak times. The utility can work in cycles, turning off 100 air conditioners every 15 minutes to limit the load from the air conditioners.

"In conjunction with this type of load-control strategy, PV is a very strong DSM tool. The tools—PV and the load-control switches—are stronger together than separately."

Osborn agrees. "In the short-term, PV is a valuable DSM tool when coupled with a specific, high-value application. An example of a high-value application is when a highly reliable circuit, such as for computers, is needed. PV can provide higher reliability and cleaner power than the utility grid itself." According to experts, this is critical because PV provides an independent source of energy for critical loads in times of blackouts, brownouts, or disasters such as earthquakes and windstorms.

Inspecting a solar domestic hot water (SDHW) system are Cliff Murley (left), SDHW Program Coordinator, and Donald Osborn, Sacramento Municipal Utility District Program Manager.

Sacramento Municipal Utility District / VL1105

Customer Support for PV

Both Hoffner and Osborn recommend PV power to other municipal utilities. "PV helps you form a good partnership with your customers," Hoffner says. "You can gain valuable goodwill. For example, PV's a great alternative if a customer needs power in environmentally sensitive areas. Sometimes you're caught—customers demand power, but they don't want a transformer. PV offers an attractive solution.

"We like to be responsive to our customers—we want their loyalty. PV is especially good for municipal utilities because they're owned by their customers."

Osborn concurs. "Municipal utilities, in particular, must be responsive to their customers. They're our managers and owners. And they're demanding clean energy. PV is a modular, incremental, distributed, clean, cost-effective power source that our customers support." ■

Why PV?

Here are some of the reasons public utilities are installing PV systems in their service territories. PV systems are

Easy to maintain and cost effective. PV cells use the energy from sunlight to produce electricity—the fuel is free. With no moving parts, the cells require little upkeep. Because the energy is produced where and when it is needed, complex wiring, storage, and control systems are unnecessary. These low-maintenance, cost-effective PV systems are ideal for supplying power to communication stations on mountain tops, navigational buoys at sea, or homes far from utility power lines.

Modular. A PV system can be constructed to any size, and panels can easily be added to a PV system to increase the energy output. This flexibility allows users to start small and expand gradually. PV systems are also a source of portable power—they can be moved to provide power for temporary loads in a service territory, then moved again when needed elsewhere.


Warren Gretz, NREL / VL1101

Mayor Susan Thornton examines one of 40 solar panels providing clean, renewable electricity to a park irrigation project in Littleton, Colorado.

Environmentally benign. Because they require no fuel, PV systems are clean and silent—selling points with utility customers.

Highly reliable. PV cells were originally developed for use in space, in which repair is extremely expensive, if not impossible. PV still powers nearly every satellite circling the earth because it operates reliably for long periods of time with virtually no maintenance.

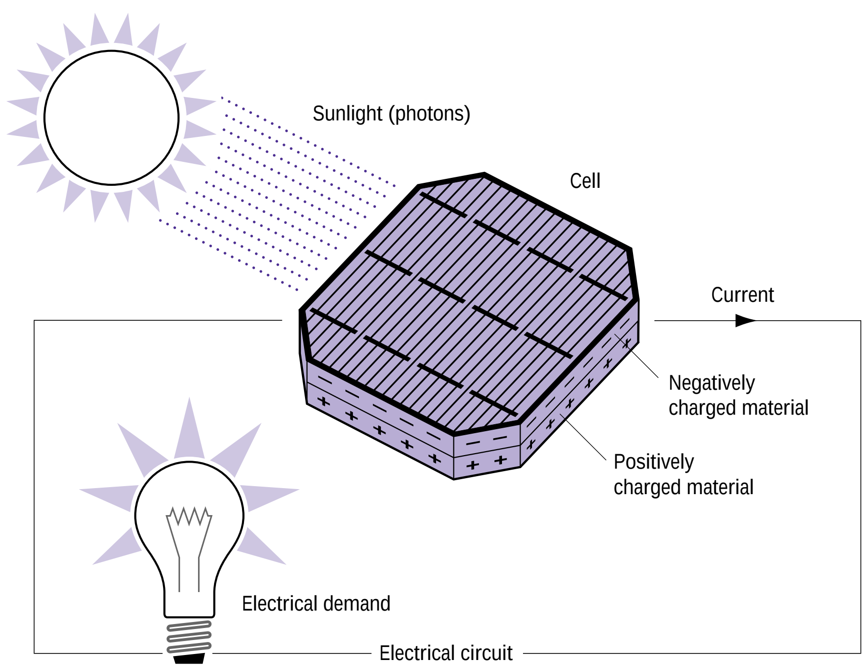
Practical. From bus stops to fire stations, PV systems can provide cities and counties with a reliable, and often the least expensive, source of power. For example, PV power can be used for

- Bus stop shelter, parking lot, and street lighting
- Automated sectionalizing switches
- Cathodic protection
- Communications, such as emergency call boxes
- Warning signals
- Railroad crossings
- Portable power
- Livestock watering pumps
- Bridge ice-detection systems
- Irrigation
- Rural or isolated residences
- Traffic preemption systems for fire stations
- Pond aeration
- Automatic traffic recorders.

How Photovoltaic Systems Work

Photovoltaics (PV) is the direct conversion of sunlight to electricity by solar cells. When photons of sunlight are absorbed in solar cells, the photons free electrons from the cell's atoms, creating a voltage potential. This is known as the **photovoltaic effect.** This is possible because various elements, added to the cell materials, establish an electrical field that causes electrons to move in one direction. Connecting wires to the two sides of a cell and to a load allows an electrical current to flow, just as with a battery. A 100-square-foot (9.3-square-meter) PV system will generate a peak power of about 1 kW, energy enough to meet many power requirements of an average U.S. home.

Photovoltaic Cell Converts Sunlight Directly to Electricity



Source: Florida Solar Energy Center

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John Hoffner can provide additional information on the City of Austin Electric Utility's PV program.

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Donald Osborn can provide more information about SMUD's PV program.

Bethany Wills
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1800 M Street, NW, Suite 300
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(202) 857-0898
Fax (202) 223-5537
Bethany Wills can provide information on the Utility PhotoVoltaic Group, a group of more than 80 U.S. utilities organized to promote the use of PV for the benefit of utilities and their customers.

Roger Taylor
National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, CO 80401
(303) 384-6432
Roger Taylor can provide information on PV technology and applications.

Electric Power Research Institute
207 Coggins Drive
Pleasantville, CA 94523
(510) 934-4212
Early, Cost-Effective Applications of Photovoltaics in the Electric Utility Industry, EPRI TR-100711, Project 1975-06, Final Report, December, 1992.

PV Design Assistance Center
Sandia National Laboratories
Albuquerque, NM 87185-0753
(505) 844-3698
The PV Design Assistance Center can provide useful and practical information based on its application experience.

Photovoltaics for Municipal Planners
To order a copy of this publication, call the National Renewable Energy Laboratory Document Distribution Service at (303) 275-4363, document no. NREL/TP-411-5450.

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